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Research Paper

Spray cooling for high temperature of exhaust gas using a nozzle array in a confined space: Analytical and empirical predictions on cooling capacity

Wei Ye, Qianru Zhang, Yuliang Xie, Jian Cai, Xu Zhang

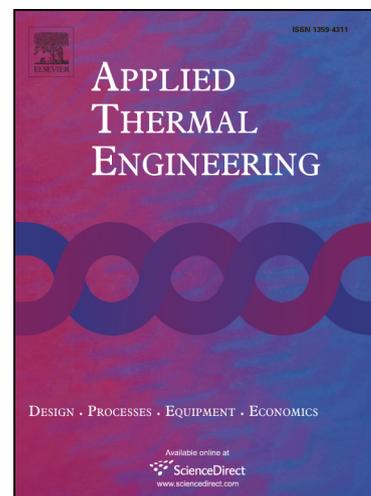
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1 **Spray cooling for high temperature of exhaust gas using a nozzle array in a**
2 **confined space: Analytical and empirical predictions on cooling capacity**

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4 Wei Ye ^{a,b,*}, Qianru Zhang ^a, Yuliang Xie ^a, Jian Cai ^a and Xu Zhang ^a

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6 ^aSchool of Mechanical Engineering, Tongji University, Shanghai, P. R. China

7 ^bState Key Laboratory of Pollution Control and Resource Reuse, Tongji University,
8 Shanghai, P. R. China

9

10 *Corresponding email: weiye@tongji.edu.cn

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12 **Keywords:** evaporative cooling; back pressure; cooling effects; evaporation ratio;
13 humidity ratio

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15 **ABSTRACT**

16 High-temperature exhaust gas generated from turbines is a common issue among
17 industrial applications. A wet system, e.g., spray cooling, can be an effective way to
18 decrease the temperature, especially in limited spaces when ventilation can be
19 ineffective. In this paper, the performance of water spray cooling on
20 high-temperature (above 450 °C) exhaust gas using a 4×4 nozzle array, which consists
21 of eight pressure-type spiral nozzles (PN) and eight impinging-type nozzles (IN), in a
22 confined chamber was investigated. A standard procedure was developed to perform
23 spray cooling tests at three back pressures (BPs), i.e., 0.5 MPa, 1.0 MPa and 1.5 MPa.
24 Four cross-sections were dedicated to measure dry-bulb temperature and one of them
25 can report wet-bulb temperature, all in real time. The results show that, first, spray
26 cooling can decrease the temperature of exhaust at the four sections by approximately
27 10 ~ 100 °C, depending on working nozzles' row and flowrate. The position of
28 working nozzles has a significant impact on the cooling effects near the exhaust outlet,
29 but not for the distant sections since the air and the exhaust can be better mixed.
30 Second, both types of nozzles have similar correlations between BPs and flowrates.
31 However, it is easier for IN to contribute to humidity ratio increment due to better
32 atomization at higher BPs. As a result, the moist air during IN tests was prone to get
33 saturated and significantly compromised the ability of evaporative cooling. Third,

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